Mycorrhiza: Meaning, Types and Role

Article Shared by Neelesh T

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In this article we will discuss about:- 1. Meaning of Mycorrhiza 2. Features of Mycorrhiza 3. Types 4. Role in Agriculture and Forestry.

Meaning of Mycorrhiza:

Vitadini (1842) was the first to recognise the possible beneficial role of fungal mycelia which mantle the root of higher plants, and this association is named as mycorrhiza (pl. mycorrhizae) i.e., the

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Thus mycorrhizae are the symbiotic associations between plant root and fungi, with bidirectional nutrient exchange between the partners.

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The autotrophic host plant acts as the carbon source for the fungus, while the fungus supplies mineral nutrients to the plant. About 90% of all land plants are associated with mycorrhiza. The mycorrhizal association is not available in Cruciferae, Chenopodiaceae and Resedaceae.

Features of Mycorrhiza:

Scannerini (1988) briefly pointed out the common features of mutualistic symbionts.

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(i) Absence of any phytopathological symptoms in the partners during the active phase of mutualism,

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(ii) Presence of complex interfaces between cells of the partners with a predominant type of perisymbiotic membrane, surrounding intracellular symbionts,

(iii) Presence of various types of phagocyte-like structures during establishment of symbionts and during harvesting phase to control the symbiotic population by the host.

Types of Mycorrhiza:

Peterson and Farquhar (1994) classified the mycorrhizae into seven

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These are :

(1) Ectomycorrhizae,

(2) Vesicular-arbuscular mycorrhizae,

(3) Ectendomycorrhizae (Arbutoid),

(4) Ericoid mycorrhizae,

(5) Centianoid mycorrhizae,

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(6) Orchidoid mycorrhizae, and

(7) Monotropoid mycorrhizae.

(1) Ectomycorrhizae:

Ectomycorrhiza is commonly called "sheathing mycorrhiza". They occur in 3% of all seed plants in forests of tem-

e, beech,

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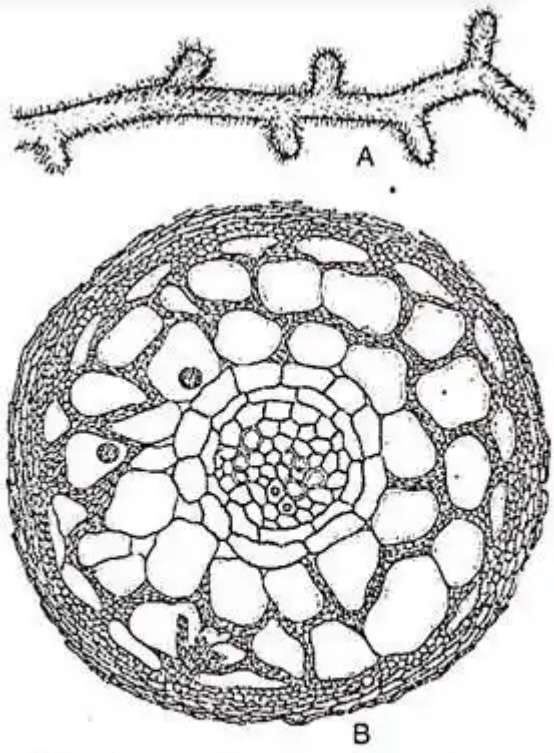

Fig. 4.103 : Ectomycorrhiza : A. *Pinus* root covered with mycorrhizal fungi, B. T.S. of *Pinus* root showing ectotrophic mycorrhizal fungi forming a mantle covering and growth of fungi between cortical cells

Generally they cause extensive branching and growth of roots and modification of branching pattern, such as racemose type in dicots (Fagus) and dichotomous in gym- nosperms (Pinus). In beech (Fagus) the ultimate lateral rootlets are differentiated into 'long' and 'short' roots.

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The long roots show indefinite growth and their branches are the short roots that are thickened, forked and

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etc., depending on the colour of the fungus. The fungus enters the cortex forming 'Hartig net', but never goes inside the endodermis or stele. They form a mantle of varying thickness (Fig. 4.103A, B).

Majority of the fungi belong to Agaricales of Hymenomycetes under Basidiomycotina. More than 100 species of toadstools are reported to form mycorrhiza. Most of the members are belonging to the genera Amanita, Tricholoma, Boletus, Russula, Lactarius etc.

Members of Gastercmycetes under Basidiomycotina like Rhizopogon and Scleroderma are involved in this process. Some members of Ascomycotina like Gyromitra esculenta, all species of Tuber (T. melanospora) form mycorrhizae.

(2) Vesicular-arbuscular mycorrhizae (VAM):

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It is a type of endomycorrhizal asso-ciation, where both vesicles and arbuscles are developed together. VAM is by far the commonest of all mycorrhizae

han 90%

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They are found in bryophytes, pteridophytes, gymnosperm (except Pinaceae) and most of angiosperms, commonly in Leguminosae (Fabaceae), Rosaceae, Gramineae (Poaceae) and Palmae (Arecaceae). VAM is not found in Ericaceae and Orchidaceae, where other type of association is available. VAM has even been reported in Lower Devonian plant, Rhynia.

VAM is produced by aseptate mycelial fungi belong to Endogonaceae under Mucorales of Zygomycotina and those members produced zygospores. The important genera involved in VAM are Glomus, Gyrospora, Acaulospora etc. Most of the members are not culturable.

The VAM is so named because of the presence of two characteristic structures i.e., vesicles and arbuscles:

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(i) The vesicles are thin or thick walled vesicular structures produced intra-cellularly and stored materials like poly-phosphate and other minerals (Fig. 4.104).

(ii) The arbuscles are repeated

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4.104).

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The arbuscles live for four days and then get lysed releasing the stored food as oil droplets, mostly polyphosphate.

There is no fungus mantle, but only a loose and very sparse network of septate hyphae spread into the soil. These hyphae bear different types of spores, chlamydospores, or aggregation of spores in sporocarp or zygospores. The superficial hyphae bear branches that penetrate the epidermis and then grow intercellularly only in cortex.

Intercellular hyphae form arbuscles inside the parenchyma of cortex by repeated dichotomous branching of the penetrating hyphae. The cell membrane of the penetrated cell is invaginated and covers the arbuscles.

The hyphae also develop both inter- and intracellular thick-walled vesicles. The chlamydospores may germinate on nutrient agar, but the hyphae stop growing when food inside the spore is used up, thus they cannot be subcultured.

This type of association was present very early in the evolution land plants.

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Asteroxylon. Later, Pyrozinski and Mallock (1975) proposed the mycorrhization/lichenisation association as a prelude to land plant evolution.

(3) Ericoid mycorrhizae:

This is actually a type of endomycorrhiza. Ericoid mycorrhizae are found in the different members of Ericaceae like Erica, Calluna, Vaccinum, Rhododendron etc. The fungi are slow-growing, septate and mostly sterile. They are mostly culturable. Both Pezizella ericae (Ascomycotina) and Clavaria vermiculata (Basidiomycotina) have been isolated from Rhododendrons.

During this association the rootlets of the plants are covered by very sparse, loose, dark, septate hyphae that penetrate the cortex forming intercellular coils (Fig. 4.105). After 3-4 weeks the coils degenerate like arbuscles of vesicular-asbuscular mycorrhiza (VAM).

Most of the members of Ericaceae grow in acid soil with less amount of P and N nutrition. The fungus gets the photosynthate from the host and improves the mineral uptake and

and N.
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high resistance to metals like Zn and Cu. The mycorrhizal plants also show high tolerance to these metals, which is totally absent in non-infected plants.

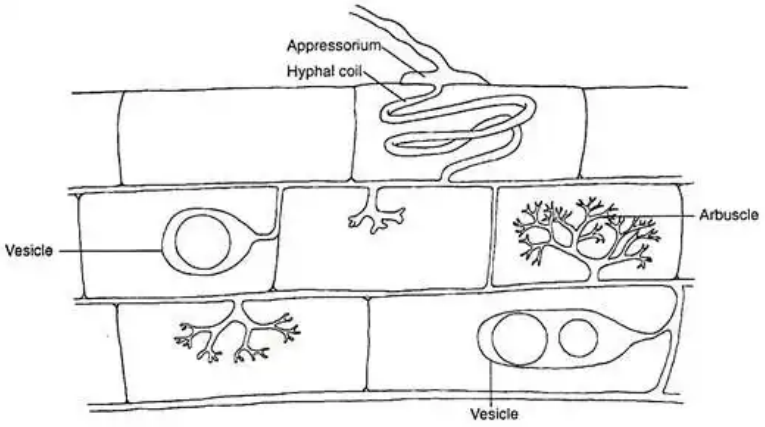

Fig. 4.104 : Vesicular-arbuscular mycorrhiza showing both vesicles and arbuscles

(4) Ectendomycorrhizae (Arbutoid):

Some members of the family Ericaceae and members of other families of Ericales have mycorrhizae intermediate in form between ecto- and endomycorrhizae types, called ectendomycorrhizae. Arbustus and Arctostaphylos of Ericaceae show this type of mycorrhizal association.

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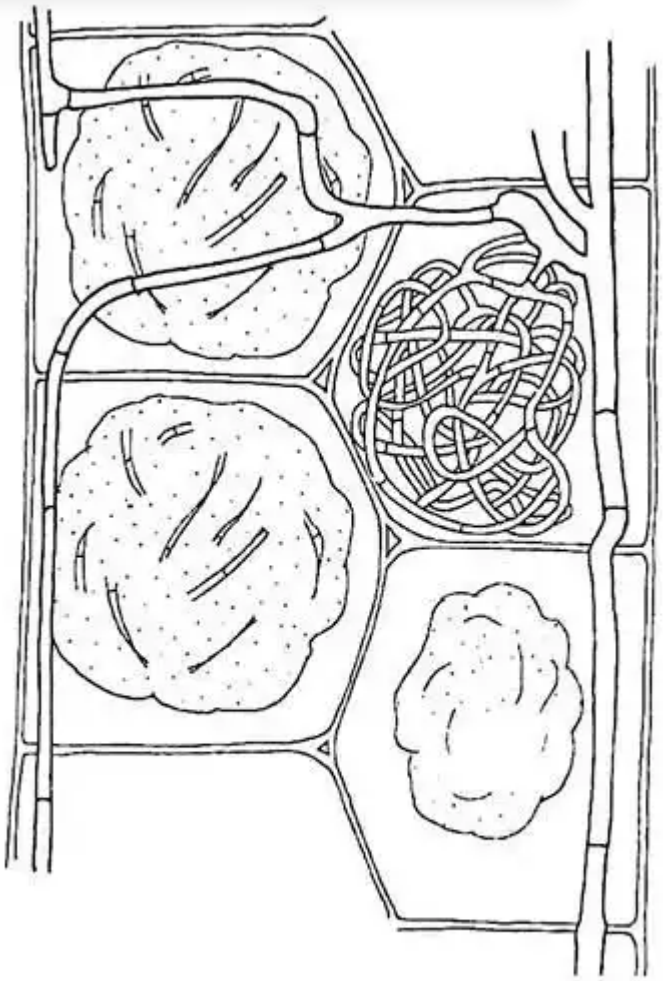

Fig. 4.105 : Ericoid mycorrhiza in rootlet in *Erica* with active and lysed hyphae

In Arbustus, the root system is differentiated into long and short roots. The short roots are swollen and covered by hyphal mantle. Hartig net is absent in this association, but intercellular coils develop in the outer cortical cells. Nothing is known about the fungi involved in this association.

(5) Gentianoid mycorrhizae:

Seedlings of some members of liata, fected

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within 2 weeks of germination. In root, the cortical cells become full of irregular coils of aseptate hyphae. With time the hyphae become lysed. Vesicles are occasionally seen attached to these coils.

(6) Orchidoid mycorrhizae:

Orchids produce millions of tiny seeds per capsule, weighing about 0.3-14µg. The embryo of seeds contains 10-100 cells and there is virtually no storage of food. The embryo is encircled in a thin-walled net-like testa that helps in their dispersal.

Thus, majority of seeds are unable to germinate without exogenous supply of carbohydrates. Therefore, mycorrhizal association is obligatory for the seeds to germinate. The fungus provides C-nutrition to the seeds.

Initially the fungus enters the embryo and colonises, being restricted to the cortical cells and provides the nutrition (Fig. 4.106). For non-green orchids, this is obligatory throughout their lives. Apparently, it is a case of parasitism by orchids on the mycorrhizal fungi.

Fungi like Rhizoctonia

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Ceratobasidium etc., of Aphylloporales are associated in this type of mycorrhiza.

(7) Monotropoid mycorrhizae:

Monotropa hypopitys is a non-green saprophytic herb. It has short fleshy roots that are invested with a hyphal sheath and often forming Hartig net in the cortical zone. Due to absence of chlorophyll, they are unable to synthesise and supply carbohydrate to the fungus. Boletus is a mycorrhizal fungus associated with roots of both pine and Monotropa.

When ^{14}C glucose was injected into the phloem of Pinus trees, significant amount of radioactive glucose (^{14}C) was recorded in Monotropa (but not in other herbs) after 5 days. This indicates that the fungus Boletus acts as a bridge between Monotropa and Pine plants.

Similarly, ^{32}P injected into Monotropa was also detected in Pine roots within 2 hours. The above facts indicate a bidirectional flow of nutrients between the plants through the fungus Boletus.

Role of Mycorrhizae in Agriculture and Forestry

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1. The mycorrhizal association helps in the formation of dichotomous branching and profuse root growth, thus enhances plant growth.

2. Ectotrophic mycorrhiza helps in uptake of mineral ions and also acts as reservoir.

3. They also help in absorption of nutrients.

4. In nutrient deficient soil, the mycelial association helps in the absorption of N, Ca, P, Zn, Fe, Na and others.

5. Mycorrhizal association is obligatory for the germination of orchid seeds.

Mycorrhizal growth in orchids (Rhizoctonia repens with Orchis militaris tuber tissues) causes the synthesis of phytoalexins — orchinol and hirsinol. Both the compounds act as a barrier to protect infection by other pathogens.

6. Inoculation of VAM as biofertiliser provides a distinct possibility for the uptake of P in phosphorus-deficient soil.

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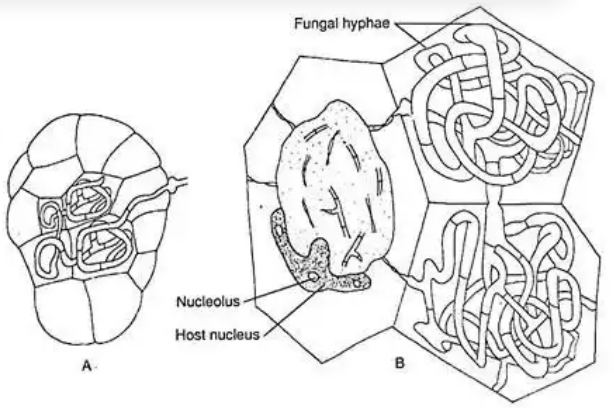

Fig. 4. 106 : Orchidoid mycorrhizae : A. Swollen embryo with initial infection, B. Cortical cells of *Dactylorchis* root showing coiled active and lysed hypae

Role in Foresty:

1. Mycorrhiza plays an important role to establish forest in unfavourable location, barren land, waste lands etc.

2. Trees with facultative endomycorrhiza act as first invader in waste lands as pioneer in plant succession.

3. The application of mycorrhizal fungi in forest bed enhances the formation of mycorrhizal association that prevents the entry of fungal root pathogens. This method is very much effective in the root of Pinus clausa against Phytophthora cinnamoni infection.

4. Mycorrhiza mixed nitrogenous compounds such as nitrate; ammonia etc. is available to the plants. Thus it helps in plant growth, especially in acid soil.

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